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ABSTRACT

This study was conducted to develop insights into how teachers integrate calculators into their course of study. The researcher met with a fifth grade and a sixth grade teacher to plan and implement a 10-day project or mini-unit focused on promoting calculator use. It was agreed that the project would include activity-based lessons to introduce the calculator, a learning center with activities or cooperative group activities, and a science project that integrated mathematics. As resources, the teachers were given commercially prepared calculator materials and were encouraged to make their teaching plans by adapting suitable materials and creating new materials as needed. Meetings were scheduled on a regular basis; ad hoc meetings and phone calls were encouraged to help teachers resolve any daily concerns. An array of methods were used to collect data including participant observation, interviewing, and document collection. Results suggest areas that need to be addressed such as providing ongoing professional development focused on mathematics content, pedagogy, and assessment. Additionally, teachers need planning time to prepare for teaching. (Author/MKR)

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Teaching and Learning: Calculators in 5th & 6th Grade

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Abstract

A fifth grade teacher and sixth grade teacher participated in this study. The researcher and research assistant met with the teachers to plan and implement a 10 day project or mini-unit focused on promoting calculator use. It was agreed that the project would include activity-based lessons to introduce the calculator, a learning center with activities or cooperative group activities, and a science project that integrated mathematics. As resources, the teachers were given commercially prepared calculator materials and were encouraged to make their teaching plans by adapting suitable materials and creating new materials, as needed. Meetings were scheduled on a regular basis; ad hoc meetings and phone calls were encouraged to help teachers resolve any daily concerns. An array of methods were used to collect data including participant observation, interviewing, and document collection.

Results suggest areas that need to be addressed such as providing ongoing professional development focused on mathematics content, pedagogy, and assessment. Additionally, teachers need planning time to prepare for teaching.

Introduction

This study was conducted to develop insights into how teachers integrate calculators into their course of study. It was part of a longitudinal study observing the changes in teaching and learning of mathematics in a suburban school district in the Midwest and was designed to pilot content, methods, and assessment practices using calculators that could be shared with other 5th and 6th grade teachers in a summer program focused on integrating calculators into the mathematics program. This paper will present a discussion of the findings related to the teachers' role in teaching and learning using calculators.

Perspective(s) or theoretical framework

The idea that mathematics exerts a unique influence in the classroom context in which it is being taught and learned, results from a relatively recent concern in mathematics education, i.e., the consideration of the mathematics classroom culture (Nickson, 1992). It is vital to the reform movement to research ways to promote teacher change in mathematics teaching in such a way that the positive elements of the classroom culture are interconnected with mathematics. Researching ways to promote a growth-and-change view of the nature of mathematics could then be compared to reforms in other domains such as reading and language arts, thereby making it easier for teachers to assimilate changes in mathematics teaching into practice. The interpretivist tradition of ethnographic research, provides methodologies for studying the evolution of change in mathematics teaching and learning. Constructivist methods provide a perspective to study the reality of the classroom (Koehler & Grouws, 1992). Steffe and Killion (1986) state that, "*mathematics teaching consists primarily of the mathematics interactions between a teacher and children*" (Nickson, 1992). From these studies, insights can be gained to change undesirable practices (Eisenhart, 1988).

Technology, in this case calculators, provide an avenue to accept the researcher's presence in the classroom over extended periods of time. Practitioners are aware that technology should be integrated in the curriculum but they often do not know how to use the technology to meet the objectives. This need provides an open door to classrooms and schools that may once have been out-of-reach to the researcher. Communication between different research traditions will provide insight into changes in teaching and learning that will take mathematics education into the 21 century.

Methods

Data source

Ms. S., a fifth grade teacher (22 students) and Ms. G., sixth grade teacher (26 students), participated in this study. Each teacher taught their heterogeneous group of homeroom students all subject except social studies, and then teacher taught science to another homeroom at their grade level. Ms. S.'s educational background is in special education and this was her third year in the district after having taught in another regional district for 1 year. She also coached the girl's cheerleading team. Ms. G. is a veteran elementary level teacher who taught 4th grade for over 10 years in the school and was completing her 2nd year teaching 6th grade. She was a leader in the district's move implementation of a whole language approach to teach reading and writing. Both teachers represented their grade level teachers on the district's mathematics committee and had participated in programs and workshops to improve the teaching and learning of mathematics. They volunteered to participate in this project and considered assuming a role of teacher leader in the following summer's program.

Procedure

During Winter 1994, the researcher and research assistant met with the teachers to plan and implement a 10 day project or mini-unit. It was agreed that the project or mini-unit would include a) activity-based lessons to introduce the calculator, b) a learning center with activities or cooperative group activities in mathematics, science, and/or social studies, and c) a science project that integrated mathematics and calculation. The researcher had identified grade level mathematics objectives that required use of calculators as part of a teacher grant project that would take place the following summer. The teachers were given commercially prepared calculator materials and other

materials prepared by the researcher, and encouraged to make their teaching plans by adapting suitable materials and creating new materials as needed to focus on mathematics objectives. Meetings were scheduled on a regular basis, and ad hoc meetings and phone calls were encouraged to help teachers resolve daily concerns.

An array of methods were used to collect data including a) classroom observations and field notes (researcher and research assistant), b) video tapes of classroom sessions, c) a paper-pencil questionnaire and follow-up interview to assess students' choice of computational techniques (calculator, mental math, or paper-pencil) to solve computation problems, d) a pre- and post-treatment assessment of students' disposition toward calculator use, e) an assessment of whether students' reached criteria on a course-of-study objective that required calculator use, f) audio taped interview sessions, g) student journals, and h) classroom teacher journals.

Data was review by the researcher, research assistant, and to some degree by the teachers. Notes were taken of the videotaped classroom sessions and student journals. Categories of meaning emerged and were coded throughout the data. Responses to open ended student questions were categorized; data from students' Likert type responses was entered into a statistics program and analyzed¹. A discussion of verification steps that were taken to assure the accuracy of the study follows.

Internal validity was assessed by triangulation among sources of information, and between the researcher and research assistant, and in some cases the teachers. For example, discussions took place throughout the project both at scheduled meetings and informally in the classroom. In the summer session, Ms. G. said that she was there to learn concepts she found she did not understand when trying to teach them and offered examples of her thinking and of typical student responses. The categories that emerged from the data support the study's external validity. The projects uniqueness within a specific context mitigates against replicating it exactly in another context. However, the general assumptions of the study which were discussed in this section along with the methods of data collection provide enough information that the project could be replicated (Creswell, 1994). To establish trustworthiness, time was spent at the research site and in discussion with the teachers. Efforts were made to build sound relationships and to corroborate points among the researchers and teachers. The following section will present the data related to the teachers by category.

Findings

Ongoing Professional Development

Although both teachers had recently participated in other courses and inservice programs to improve teaching and learning in mathematics, neither felt prepared to take a leadership role with other teachers during the summer program. One teacher decided to go back to school to become an administrator, and the other teacher continued participated in the summer program and designing an activity center project for her students. She continued to revise her thinking and build her knowledge base; she was willing to share what she knows with other teachers in a collegial manner. In both cases, the teachers need ongoing professional development in mathematics and in both teachers seemed aware of this need which was heighten during their attempts to teach mathematics content they did not understand. More specifically, professional development falls into the categories of mathematics content, pedagogy, and assessment which will now be discussed in more detail.

Mathematics Content

The teachers' misconceptions in mathematics content knowledge caused some of the students' misconceptions. For example, in an early planning meeting the researcher's notes suggest this might become a problem.

¹ See *Proceedings of the Seventeenth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (October 21- 24, 1995). Columbus, OH: ERIC clearinghouse.

(They're) concerned with long division. I suggested the relationship of long division to fractions. I question how I can teach them the math content that might be needed for them to field the open ended questions of their students.

Another example, can be found throughout the data as the teachers worked with students to differentiate between calculators with arithmetic logic and those with algebraic logic. The researchers became aware of Ms. S.'s lack of understanding and attempted to guide her to understanding of this concept in various ways, but to no avail. The researcher noted:

She had overheard my discussion with the students about the problems in their journals--order of operations... They (students) could not differentiate between arithmetic and algebraic logic--'wrong' answers (in journal) yet no idea that they were wrong. Rather than building on what was done yesterday, she opted to do something ... sit at her desk during math class.

The teacher's journal states that she is aware of problems:

Was a very hectic day! This lesson was short working with order of operations! We discussed the procedures and then they were given problems to complete in their journals. This was very confusing for them! We are definitely going to touch more on this next week.

The next time the concept was discussed was two months after the lesson. The discussion followed the assessment of this concept (delayed because planbook was already written) and it reinforced misconceptions about the functioning of the calculators with no attention given to the order of operations.

Pedagogy

Current methods, such as cooperative learning groups, encouraging multiple solutions to a problem, student discussion, etc., were used in both classes. The methods often seemed routine. Students did not seem motivated or were in varying degrees not engaged in the tasks in an active way. More specific categories emerged for this data such as professional responsibilities, planning, classroom supervision, classroom management, interaction with students, and teacher language. These areas affected the teaching and learning in the classroom. For example, the researcher and assistant observed that in one classroom planning was done on a daily basis. In the other classroom, plans were entered in the plan book for 3 or more weeks and followed daily without regard to an assessment of the concept or skill that was presented. The teachers said they were satisfied with their planning strategies but they interfered with the project. For example, materials were not reviewed and shared in a timely fashion and concepts were "covered" rather than taught for understanding. Additionally, the teachers need to learn how to adapt materials for classroom use. They were not familiar with a "multi-text" or "multi-material" approach in mathematics. They need to apply what they know about planning for instruction in other areas, such as Whole Language, while preparing for mathematics instruction.

Assessment

Both teachers had the students keep a mathematics journal. One teacher used the information from the journals to inform her about further instruction and the other teacher did not do so. Journaling and discussion often seemed over used. Selected students were engaged in journal reports, and small group presentations while other students remained almost anonymous.

Time

Time to prepare for teaching was not available during the day, before school, or after school because of other personal and/or professional commitments. The teachers tended not to extend into their time to prepare for the classes and so minimum planning took place during the study. Other changes in time caused by events such as snow days, changes in internal scheduling, and frequent teacher absences caused additional problems. Time related problem need to be addressed by the schools.

Importance of the study

The changes in mathematics content, pedagogy, and assessment practices that are being espoused in the reform movement call for teachers to develop their concepts, knowledge and skills, and problem solving abilities in mathematics as well as to have a positive disposition toward mathematics. The teachers need to know and understand content and procedures that are new to them if they are going to teach students in a meaningful way. For those teachers harboring fears of mathematics, their learning experiences need to take place in a way that promotes a positive disposition toward mathematics.

New tools such as calculators and computers, as well as manipulative materials open the classroom door to reform because practitioners know that they need to learn about the innovations. However, the time frame for change is atypical in schools where a new textbook or other innovations are typically assimilated or dismissed into the school culture within a school year or two. An ongoing process of professional development needs to be established to support teachers throughout the current reforms.

The teachers in this study were working to teach the students a few objectives in the course-of-study. Even with materials and the ongoing university support throughout the project, the students who were assessed on a "critical objective" (Ms. S.'s class) did not meet the objective. The barriers to student achievement in this case can be attributed to the teacher. In the other class, examples of this were also found. To change these undesirable outcomes, innovative ways to provide ongoing professional development and support for teachers are needed. Hopefully, as this research continues, insights will be gained into how to do this.

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